

PRIMARY USE: Control of storm runoff.

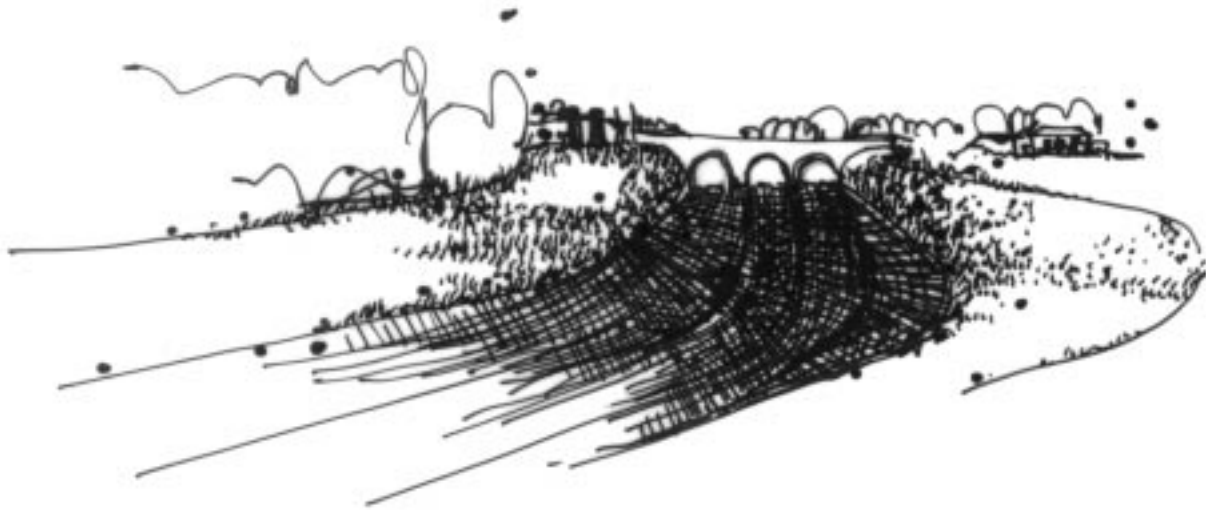
ADDITIONAL USES: Reduce erosion from storm runoff.

LINED WATERWAY

What is it? A waterway or outlet having an erosion-resistant lining of nonreinforced, cast in-place concrete; flagstone mortared in place; rock riprap; or similar permanent material.

Purpose

To provide for safe disposal of runoff from other conservation structures or from natural concentrations of flow, without damage by erosion or flooding, where unlined or grassed waterways would be inadequate.



**Lined Waterway
Perspective View**

Limitations

The maximum capacity of the waterway flowing at designed depth is 200 cubic ft/sec (5.7 cubic m/sec).

Materials

Nonreinforced, cast in-place concrete; flagstone mortared in place; rock riprap; or similar permanent material.

Installation

Flexible liners are preferred to rigid liners, and riprap is the flexible liner of choice because of: low cost, ease of repair; adjusts to unstable base; roughness of riprap reduces velocity; allows infiltration. Rigid liners carry larger volumes without erosion, take up less area, can be constructed to fit limited site conditions, and require less maintenance. They are more expensive, are harder to construct, and introduce higher water velocities which must be dissipated. The minimum capacity should be adequate to carry the peak rate of runoff from a 10-year frequency storm. Waterways or outlets with excessive velocities should discharge into an energy dissipator to reduce velocity. The minimum freeboard for lined waterways or outlets shall be 0.25 ft (75 mm) above design high water in areas where erosion-resistant vegetation cannot be grown adjacent to the paved side slopes. No freeboard is required if vegetation can be grown and maintained.

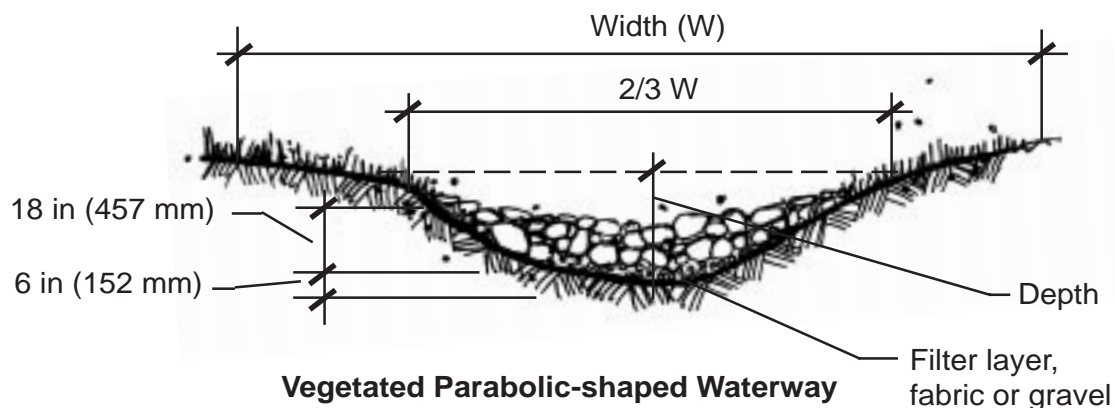
Source: NRCS Planning and Design Manual, NRCS.

LINED WATERWAY

Additional Considerations and Drawings:

Compute velocity using the Manning's equation with the appropriate "n" value.

Lining Material	"n"			
Concrete				
• Trowel finish	0.012 – 0.014			
• Float finish	0.103 – 0.017			
• Gunite	0.016 – 0.022			
Flagstone	0.020 – 0.025			
Paving blocks	0.025			
Gabion	0.025 – 0.030			
Riprap	Channel flow depth (ft)			
Size, d50 (inches)	0 – 0.5	0.5 - 1	1 - 2	≥ 2
• 6	0.106	0.054	0.044	0.041
• 9	0.215	0.068	0.062	0.047
• 12	0.797	0.084	0.060	0.053
• 15	-	0.104	0.068	0.059
• 18	-	0.127	0.076	0.064
• 21	-	0.158	0.085	0.070
• 24	-	0.199	0.095	0.076



**Lined Waterways
Section Views**

